



HISTORY OF THE FLYING WING

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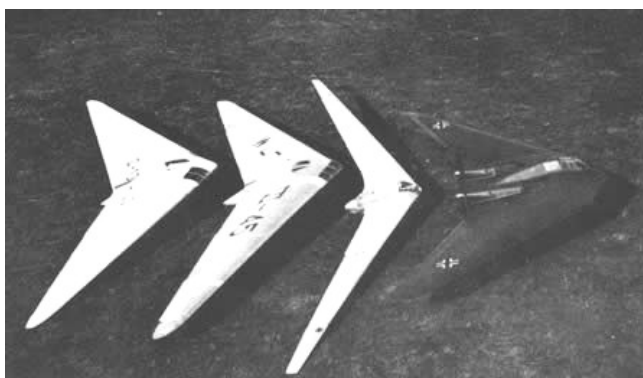
by E.T. Wooldridge



With the outbreak of World War II in 1939, the outlook for flying wing development improved immeasurably. On both sides of the Atlantic, governments were more than willing to gamble funds and manpower in a search for the right combination of weapons and aircraft that could mean the difference between victory and defeat in the air war ahead. Most of the governments that were at war took a few tentative steps in the direction of tailless fighters, but only one aircraft of the type, the Messerschmitt Me 163, was used in combat. In the United States, only Jack Northrop worked vigorously to build a flying wing, but it was not until a year after the war that the first of his giant aircraft made its maiden flight. In Germany, despite the exigencies of war, the Hortens continued to create a series of imaginative flying wing designs that culminated in the world's first turbojet-powered flying wing. The Lippisch designed Me 163 became the world's first operational tailless fighter.

Following their success with the pre-war Ho III series, the Hortens designed and built the first model officially sponsored by the German government. In the 1941 Ho IV, the Horten brothers doubled the aspect ratio of the Ho III to about 22:1. The glider featured a plywood-covered steel tube inner section containing the cockpit, in which the pilot assumed a semi-prone position to reduce drag as much as possible. This "praying mantis" position, in which the upper part of the pilot's body was horizontally inclined 30 degrees, was restful on long test flights, one of which exceeded nine hours. The wings were made of wood with fabric covering except for the outer six feet, which were made of aluminium. Using a retractable type of skid landing gear, the Ho IV took off on a wheel attached to a wooden skid. After takeoff, the wheel dropped automatically when the skid was retracted. There were no vertical surfaces on the wing, and a complex control system was employed, consisting of dive brakes that moved out at right angles to the wing surface, drag rudders, and three elevons along each trailing edge.

A variant of this aircraft was the Ho IVB, which incorporated a laminar flow airfoil with a plastic leading edge. The airfoil section was based on data obtained from wind tunnel tests of a captured P-51 Mustang fighter. Unfortunately, the Ho NB suffered from bad stalling characteristics and eventually crashed after a spin, killing the pilot. Nonetheless, the basic Ho IV, developed for distance soaring, attained a very high performance level, having been tested in extensive flight trials totalling more than 1000 hours.



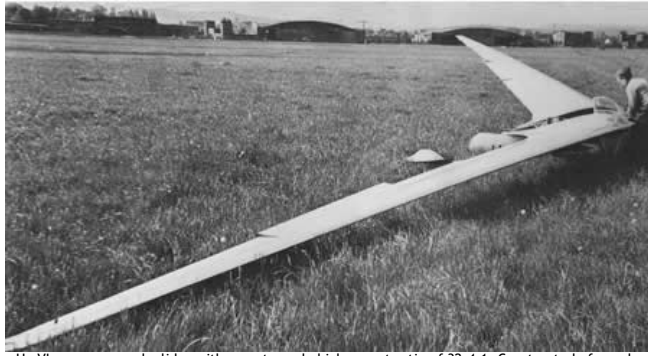
Arranged from left to right are models of four significant Horten designs: the pre-war Ho II and Ho III, the 1941 Ho IV, and the single-seat, 1942 Ho V

The Ho V, built in 1937, was the first of the Horten craft designed from the outset as a powered airplane and was the first Horten wing of sufficient size and capacity to demonstrate the commercial or military value of this type. The 1937 Ho V had two side-by-side cockpits and was powered by two Hirth HM 60R 80 hp-engines. This version was rebuilt in 1942 as a single-seater and was extensively flight tested in 1943. The Ho V, which in many respects resembled Jack Northrop's N-1M and N-9M flying wings of the same period, had a simple control system with two moving surfaces at each trailing edge, landing flaps beneath the centre section, and spoilers at the wing tips.

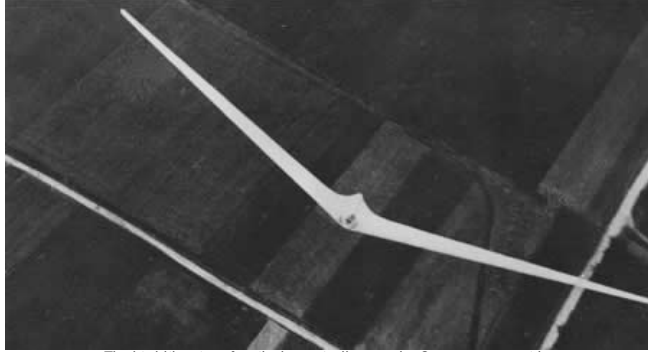
A second version of the Ho V was constructed largely of plastic using considerable sandwich material. Plastic sheeting was used for wing covering and rib webs, plastic laminate for main spar booms and stringers, and wood for rib booms. On its maiden flight, this aircraft was badly damaged in a rough landing made in high winds. A third version of the Ho V, a glider tug, was proposed but never built.

Even more unconventional than most Horten designs, the Horten Parabola had a quarter-moon shape with two parabolas meeting at the wing tips. The wing was relatively thick at the centre, and the outer panels tapered to the tips without dihedral. Only one of this model was built, and it was intentionally destroyed after moisture warped the very light structure.

The Ho VI that followed had the high aspect ratio of the Ho IV, but had a wingspan of slightly over 78 feet, 13 feet greater than that of the Ho IV. With an aspect ratio of 32.4: 1, the glider was built strictly for research and was not considered practical for private ownership. According to Walter Horten, the Ho VI behaved extremely well in tests, although it was too advanced for ordinary soaring practice and demanded great skill from the pilot.



Shown on the ground, the Ho VI was a research glider with an extremely high aspect ratio of 32.4:1. Constructed of wood and metal, the aircraft was considered by Walter Horten to be the highest performance sailplane of its day.



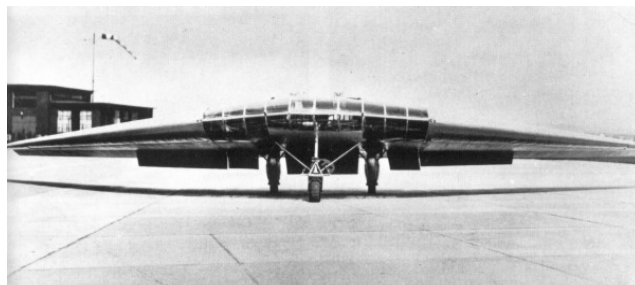
The bird-like aircraft sails dramatically over the German countryside.

Two models of the Ho VI were built, one of which was destroyed. The other was captured by the Allies and eventually delivered to the Northrop Aeronautical Institute in the United States for study and evaluation.

A more powerful successor to the twin-engined Ho V was the Ho VII, which was equipped with two 240-hp Argus AS IOC engines. Directional control of the aircraft was accomplished with wooden drag bars, mounted on rollers behind and parallel to the spar tip. Moving the rudder pedals moved one of the bars out of the wing tip to cause drag, a concept that proved unsatisfactory in flight. The Ho VII, designed to familiarize Luftwaffe pilots with flight characteristics of flying wings, was considered by Walter Horten to be the brothers' most successful aircraft. Reimar Horten tells the following anecdote concerning single engine performance of the Ho VII:



Initially constructed as a two-seater, the Ho V was rebuilt about 1942 as a single seater. Two moving control surfaces were on each trailing edge with landing flaps beneath the centre section



Ho Vb



Ho Vc

Goring wanted a demonstration of the single engine performance of the Ho VII. Heinz Scheidhauer flew to Oranienburg (Berlin) and made several low passes in front of the Reichsmarshal. The temperature of the day was 14 degrees F and Scheidhauer was unable to restart the dead engine with the compressed air starter following the demonstration. In preparing for a single engine landing he discovered that the landing gear would not lock down, since the hydraulic pump was installed on the dead engine. With the gear half extended he made a single engine go-around, then discovered that the emergency compressed air gear extension system did not work either, since the air supply was depleted in the unsuccessful engine start attempts. The Ho VII ended up on its belly in the landing.'



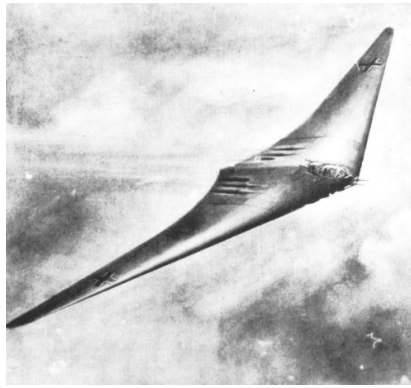
Ho V11 under final construction



Dr. Walter Horten considered this Ho VII with two 240 hp Argus engines to be the Horten brothers' most successful craft. It was to be used to familiarize pilots with the characteristics of powered tailless aircraft. Only one was completed and test flown about March 1945.

Dr. Horten adds: "It's a shame. He had an hour of fuel left, and could have flown around for a while, and charged his air bottle with the operating engine." But Goring was satisfied. By March 1945, one Ho VII was completed and undergoing tests, another was nearing completion, and eighteen more were on order.

The most ambitious of the Horten wartime projects was the mammoth Ho VIII, an aircraft with a 158-foot wing span, and six BMW 600-hp engines driving pusher propellers. It could accommodate about 60 passengers in the wing centre section. With an anticipated range of about 3700 miles, the airplane appeared to be slated for the post-war commercial market, but could possibly have been used as a military transport. Construction was not completed by the end of the war. Many years later, Reimar Horten designed another tailless transport for the *Argentina Institute Aerotecnico*. Faintly reminiscent of the defunct Ho VIII, the I.A. 38 was about two-thirds the size of the Ho VIII, was initially powered by four 450-hp Gaucho engines and had a large compartment beneath the wing centre section that could hold up to six tons of cargo. The aircraft eventually flew on December 9, 1960, but development was hampered by engine cooling problems, and the program was eventually terminated.

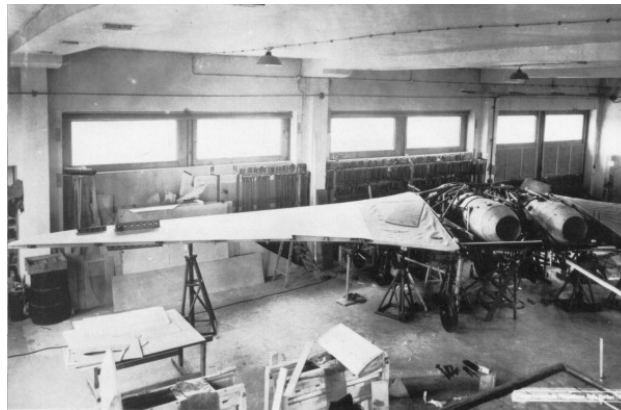


The H XVIII was to be a six engined long-range bomber.

By far the most advanced Horten design, and the first one intended for combat use, was the Ho IX jet fighter. Patterned after the conventionally powered Ho V, the radical Ho IX first flew as an unpowered glider in the summer of 1944. The aircraft consisted of a welded steel tube centre section and wood for the outer panels with plywood covering, a method of construction that was basic to all Horten craft. Reimar Horten described the construction:

The inexperienced workers available in 1944-45 could more easily be trained to work with wood, as long as the design was kept simple and primitive. Control rods and wires were inside the spar, fuel was kept in the space in front and behind. Fuel resistant glue and varnish were used, and fuel was pumped right into the wood structure without any kind of liners or bladders. Glue could be mixed with sawdust and applied over varnished surfaces to fill imperfections.

The wing skin was up to 17 mm thick; with a more refined construction, 6 mm would have been sufficient. The wood construction had some additional benefits; for instance the aircraft was almost invisible on radar. The wood panels even diffused the returns from the top mounted engines sufficiently to make radar gun sights useless. A second advantage was the minimal damage a 20 mm shell would do when it exploded inside the wing. A hole would be made, and a few ribs damaged, but the aircraft could still fly. A similar explosion inside the metal wing of a Me 109 would deform the wing so that the aircraft could not fly.



The Ho IX V2 under construction in a 3 car garage



The Gotha Go 229 (Ho IX) as it appeared after capture by United States forces at war's end. The turbojet engines exhausted over the upper surfaces of the wings, which were protected by metal plates. The sturdy tricycle landing gear retracted into the wing, the centre section of which was built up from welded steel tubing, with the outer section made of wood with plywood covering. Outer wing sections are missing in this photograph

Steel plates protected the upper surface of the Ho IX wing from the hot jet engine exhaust. The entire trailing edge of the wing consisted of three control surfaces on each side, with outer and centre surfaces giving lateral and longitudinal control, and the inner surfaces acting primarily as landing flaps. Directional control was provided by one large and one small air brake flap located above and below the outer wing. The large air brake flap did not operate until the smaller flap had fully extended, resulting in smoother control than with previous systems. Unique features of the pilot's cockpit included a seat catapult escape device and a control stick, the pivot point of which could be adjusted to increase mechanical advantage for high speed flight.



The world's first turbojet-powered flying wing, the Ho IX V2, is prepared for flight tests somewhere in Germany in January 1945.

The second model, designated Ho IX V2, was completed in late 1944. Equipped with two 1890-pound thrust Junkers Jumo 004B turbojet engines, the world's first turbojet-powered flying wing flew in January 1945. The famous German soaring pilot Erwin Ziller was at the controls. While initial flight tests were encouraging, tragedy occurred after only two hours of accumulated flight time. Ziller was killed during an unsuccessful single-engine landing. Nonetheless, with the enthusiastic support of Reichsmarshal Hermann Goring, preparations were made for mass production of the aircraft by Gothaer Waggonfabrik A.G. Accordingly, the third prototype was designated Go 229 (Ho IX V3) and was built at the Gotha factory. The aircraft was virtually completed when the workshops were overrun by Allied forces, thus terminating any further development of the series. The completed Go 229 was ultimately sent to the National Air and Space Museum in the United States and will eventually be restored. Several other Horten wings were under construction as the war drew to a close, but none reached the flight stages.

The Horten brothers made technical achievements through initiative, imagination, and tenacity. Although none of their designs were used in combat, their contribution to the growing body of knowledge on the intricacies of flying wing design was considerable, and they must be ranked with the leading pioneers in the field.

Like the Hortens, Alexander Lippisch spent the war researching the military applications for tailless aircraft. While the Horten designs were not produced in sufficient quantity to have any significant, lasting impact, one of Lippisch's designs was the most startling and revolutionary aircraft of World War II.

The DFS 194 was built in 1937. Lippisch conducted ground tests with a Walter rocket engine installed in 1940, followed by the first rocket-propelled flight in August of that year. Eventually, the world's first rocket-powered fighter evolved, the Me 163A, derived directly from the Lippisch Delta IV CDFS39.



Originally built in 1937 as an experimental prototype of a tailless fighter, the Lippisch-designated DFS 194 was later modified for installation of a liquid-fuel rocket engine. The DFS 194 was subsequently used as a test bed for the Walter engine, flying at speeds up to 342 mph; successful flight tests led to increased priority for development of the Me 163, world's first rocket-powered fighter.

A remarkable accumulation of highly imaginative designs continued to pour out of Lippisch's Department "L" at Messerschmitt during the early years of World War II. Fighters, bombers, and trainers, all tailless, came equipped with piston engines, turbojets, or rocket engines, or combinations thereof. Some reached the model or mock-up stage but none, other than the Me 163A or its derivatives, ever reached flight test.



Alexander Lippisch's work with tailless aircraft during the 1930s led directly to the most revolutionary operational fighter of World War II, the Messerschmitt Me 163 Komet. Shown here is one of the B-series prototypes, the Me 163BV2, which made its first rocket-powered flight on June 24, 1943.

In May 1943, Lippisch became Director of the Luftfahrtforschungsanstalt Wien (LFW, Aeronautic Research Institute, Vienna) where he began research on the development of supersonic aircraft. Efforts centred around the use of the ramjet engine as the propulsion unit. Project P 12 was conducted under the most arduous circumstances, with Allied bombing a constant threat. Shortages of strategic materials and skilled engineering personnel hampered the orderly progression of research programs. Nonetheless, the P12 and P13 reached the model stage, with wind tunnel and free-flight tests showing enough promise to warrant construction of a ramjet-powered manned aircraft.



Project P12, shown in model form, was to be an experimental aircraft equipped with a ramjet engine. Since ramjet engines do not produce thrust at zero speed, the aircraft would have to be accelerated to flying speed either by a "piggyback" arrangement or rocket assisted takeoff.

With the end of the war imminent, the project had only reached the manned glider stage. A full-size glider model of the P13 ramjet interceptor was constructed to investigate low speed characteristics of the aircraft. Designated DM-1, the glider was not finished by the end of the war. However, at the instigation of Dr. Theodore von Karman, construction of the DM-1 was completed and it was shipped to the United States for testing.



The Lippisch W1-1 was constructed as a glider to test the low speed flying qualities of a ramjet-powered interceptor. Wind tunnel tests were conducted in the United States after the war, but the aircraft was never flight tested.

The DM-1 was tested in the National Advisory Committee for Aeronautics (NACA) Langley full-scale wind tunnel in 1946. Eight different configurations of the model were tested, with modifications of the wing leading edges, the vertical and horizontal stabilizers, and the control surfaces made to determine lift, drag, and stability characteristics. Initial tests were disappointing; lift coefficient was low, drag was high, directional stability was unsatisfactory, and the craft was considered unsafe for flight tests. In the final analysis, however, after suitable modifications, results indicated that delta wing airplanes with 60 degree sweepback and sharp leading edges could be designed to have acceptable stability characteristics at sub critical speeds.

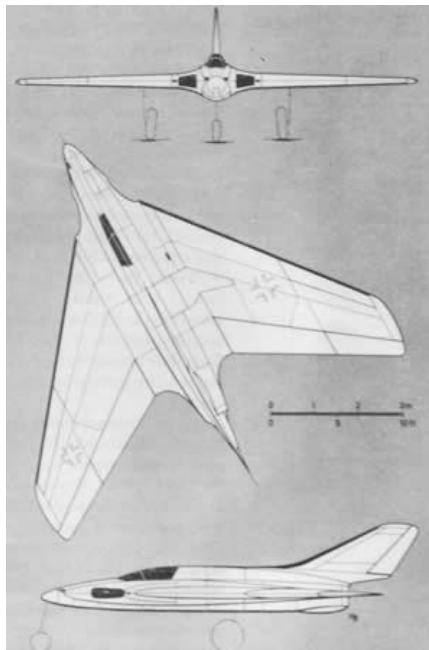
The DM-1 was Lippisch's last tangible effort for a dying cause. In 1946 he moved to the United States where after a few years of government service, he joined Collins Radio Company as an expert on special aeronautical problems. In 1966, he founded Lippisch Research Corporation and then eloped the X-113A Aerofoil Boat.

Alexander Lippisch died in 1976. He did not have an aircraft company named after him, only one of his designs was produced in quantity, and even it did not bear his name. But his experiments paved the way for the thousands of aircraft bearing the distinctive Lippisch imprint that have routinely flown in the high speed regime originally explored by Lippisch.

A general discussion of German designs for tailless aircraft and flying wings must include a brief description of some designs that were still on the drawing board at the conclusion of World War 2. Encouraged by the successes of the Horten series and the spectacular performance of the Lippisch inspired Me 163 Komet, German designers produced a series of futuristic designs in the final chaotic days of the war. If the old maxim that says if an airplane looks right, it will fly right is true, then very few of those unconventional designs would have lifted off the runway. Among the many improbable combinations of sweepback, sweep forward, variable sweep, asymmetrical arrangements, ventral and dorsal fins, and butterfly tails, there appeared a few seemingly practical configurations, some with characteristics that would appear in the post-war designs of other countries.

In the latter part of 1944, the high command of the Luftwaffe issued an urgent requirement for an improved single-engine jet fighter with performance equal to or surpassing that of the twin-engined Messerschmitt Me 262. Specifications required that the new fighter be powered by a single Heinkel/Hirth 109-011A turbojet, have a level flight speed of 621 mph at 23,000 feet, a service ceiling of 46,000 feet, and be armed with four MK 108 30-mm cannons.

Among the more plausible proposals submitted in response to the Luftwaffe requirement was the Messerschmitt P.1111, a wood and metal tailless fighter that resembled a streamlined, sleek Me 163. Powered by the 2866 pound thrust Heinkel-Hirth 109A-011A turbojet, the aircraft featured wing mounted controls consisting of elevons, inboard split flaps and outboard leading-edge slats, and theoretically was capable of speeds over 600 mph.



German aerodynamicists showed a preoccupation with tailless aircraft during the closing days of WW 2. Representative of the scores of futuristic designs was the Messerschmitt P 111, a fairly realistic looking jet fighter in the 600 mph category.

The Heinkel response to the request for proposals was a step or two further away from the conventional direction of the Messerschmitt submissions. The Heinkel P.1078 was originally projected in three versions designated P.1078C, B, and C. The P.1078C, the preferred version, was a jet-propelled tailless aircraft with the cockpit situated over the single air intake, with cannon located on each side of the cockpit. The wing tips were drooped like those on Northrop's N-1M.

Other Heinkel designs of the 1944-1945 period included the P.1079, a two-seat night-fighter with two turbojet engines installed, and the P.1080, a single-place tailless fighter built around two ramjets delivering an estimated 3440 pounds of thrust at 621 mph. Takeoff thrust was provided by four solid fuel rockets.

In the same class with the Messerschmitt and Heinkel designs, but a bit more exotic, were the Blohm and Voss P.212 and the Junkers EF 128.